DESIGN AND FABRICATION OF POWER DIVIDER AT 2.4 GHZ USING NORMAL MATERIAL BOARD AND FABRIC MATERIAL

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To my beloved family and friends

for their endless and unconditional support

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ABSTRACT

This project describes the design, fabrication and testing of curve, taper and 90° bend power divider at 2.4GHz operating frequency. The divider network is designed using Advance Design Simulation (ADS) software by applying basic Wilkinson power divider design. The schematic is converted into layout before going to fabrication process on FR4 board and fabric materials. Each types of power divider is integrated to 1x2 array antenna that operated at same frequency as power divider for implementation stage. The project that had developed can improve electrical flow and surface current at the sharp end of array antenna's feeding line. For various function of material, fabric material is used for flexibility and wearable application. Curve power divider has better performance compared to taper and bend. Fabric material has high performance compared to FR4 board and it is able to use for wearable application.

ABSTRAK

Projek ini menerangkan reka bentuk, fabrikasi dan ujian untuk lengkung, tirus dan selekoh 90° pada pembahagi kuasa dalam operasi frekuensi 2.4GHz. Rangkaian pembahagi telah direkabentuk menggunakan perisian Advance Design Simulation (ADS) dengan menggunakan asas rekabentuk pembahagi kuasa Wilkinson. Skematik telah ditukar kepada susun atur sebelum pergi kepada proses fabrikasi menggunakan papan FR4 dan kain jeans. Setiap jenis pembahagi kuasa disambungkan kepada 1x2 antena susunan yang beroperasi pada frekuensi yang sama sebagai pembahagi kuasa untuk peringkat pelaksanaan. Projek yang telah dibangunkan boleh meningkatkan aliran elektrik dan arus permukaan pada laluan suapan bagi antenna susunan. Untuk pelbagai fungsi lain, bahan fabrik digunakan untuk tujuan fleksibiliti dan mudah pakai. Pembahagi kuasa lengkung mempunyai prestasi yang lebih baik berbanding tirus dan selekoh 90°. Kain jeans pula berprestasi tinggi berbanding papan FR4 lembaga dan ia boleh digunakan untuk mudahpakai.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADS	–	Advance Design Simulation
CST	–	Computer Simulation Technology
ENA	–	Enhanced Network Analyzer
RF	–	Radio Frequency
IMT	-	International Mobile Telecommunication

CHAPTER 1

INTRODUCTION

1.1 Introductions

Power divider is a passive microwave component used for power division. In microwave system it is often needed to distribute Radio Frequency (RF) power to various paths for different application. The easiest way to perform this operation is by employing power divider circuits. There are few types of power divider which are:

i. T-model power divider
ii. Resistive power divider
iii. Ultra wideband power divider
iv. Wilkinson power divider

In an ideal power divider, the power given in Port 1 is equally split between N-ways output for power division and vice versa for power combining as shown in Figure 1.1. However, the most familiar power divider is three sections of Wilkinson divider which has high isolation between output ports. This type of divider is simplest compares to others [1].

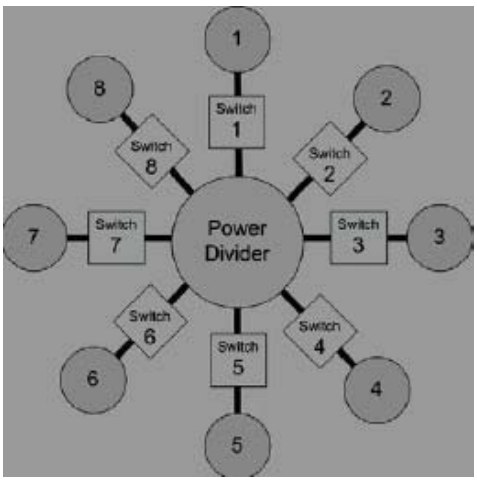

Figure 1.1: Real Time Tracking System with 8 output ports [1]

This thesis proposes the designs and development of 3 different types of Wilkinson power divider operating at 2.4GHz. The designs covered are curve, taper and bend. Fabrication materials used are positive dip coated FR4 board and fabric. A resistor has been applied to the divider to improve isolation performance. This work involves the design, fabrication and hardware measurement of the dividers for future long range communication with higher gain and sharper beam.

This thesis describes the divider's design and development including the literature review on the 3 different types of power divider, the simulation design using Advance Digital Simulation (ADS) and CST Microwave Studio software, ends up with fabrication and hardware measurement. At the final stage, the dividers are integrated to 1X2 array antenna to see the output performance.

In this first chapter, the brief background of the project is discussed, providing problem statements, objectives, methodology, and scope of work in conducting the research including the project's possible outcome and contributions and also the thesis organization.

1.2 Project Background

Power divider is a passive microwave component used for power division. Input signal is divided into N-way output signal. In the field of microwave engineering and circuit design, the Wilkinson Power Divider is a specific class of power divider circuit that can achieve isolation between the output ports while maintaining a matched condition on all ports. The Wilkinson design can also be used as a power combiner because it is made up of passive components and hence reciprocal. First published by Ernest J. Wilkinson in 1960 [1], this circuit finds wide use in radio frequency communication systems utilizing multiple channels since the high degree of isolation between the output ports prevents crosstalk between the individual channels.

Output power divided at each port can be equal or unequal, depends on requirement needed. For this project, three types of power divider are designed based on certain specification:

i. Curve power divider
ii. Tapered power divider
iii. Bend power divider

An ideal power divider design supposed to achieve 3 requirements, which are:

i. Reciprocal
ii. Matching
iii. Lossless network / High isolation

1.3 Problem Statement

Most of the array antenna's feed line built uses rectangular structure that comes with pointy edges which is strongly influences the surface current and electrical flow. Through a 2D and 3D microwave simulation, these frequency dependent electric and current values are found accumulating at the sharp end of any conventional array antenna design. A novel power divider is proposed which focusing on a better curve structure intending on enhancing smoother power transition. By using basic Wilkinson Power Divider theory, various types of the power divider design are simulated. Advances in communication and electronic technologies have enabled the development of compact and intelligent devices that can be placed on the human body or implanted inside it, thus facilitating the introduction of BANs (Body Area Networks). Huge processing and complex BANs will be needed in the future to provide the powerful computational functionalities required for advanced applications. These requirements have led to increasing research and development activities in this area for many purposes with the main interest being in health care. For various function of material, fabric material is used for flexibility and wearable application.

1.4 Objectives

This project has 4 main objectives which are:

- To design, simulate and fabricate 3-ways of curve, taper and bend of equal power divider in microstrip technology. The divider is designed to serve working frequency at 2.4GHz of bandwidth. The output ports will be arranged in array configuration of 4.
- The result will be analyzed based on S-parameter reading.
- The performances of every design shape and fabrication materials used are compare

1.5 Scope and Limitation of the Project

The main scopes of this project are:

i. Literature review and previous research study on power divider design.
ii. Design, simulate and analyze the schematic design of power divider using Advance Digital Simulation (ADS) software. CST Microwave Studio software is used for existing 1x2 array antenna simulation.
iii. Fabricate and measure each type of power divider and array antenna. The fabrication part includes isolation resistors soldering.
iv. Analyze and compare the result between simulation and measurement. The result is also compared between FR4 board and fabric material.
v. Thesis documentation.

The limitations of this project are:

i. The range frequency is limited to 2.4GHz due to the availability of existing antenna design.
ii. The E5071C ENA Network Analyzer has only two ports. Since this project is 3-ways ports with 1-port and 2-ports inputs and outputs respectively, the terminator is used for S-parameters measurement.
iii. Dielectric constant of fabric material used is taken from previous project.
iv. The antenna measurement is only taken for S11 reading, since there's no availability of anechoic chamber to do radiation pattern measurement.

1.6 Thesis Organization

This thesis is organized in 5 chapters that describe total work flow for this project. The first chapter consist of introduction, project background, problem statement, objectives of the project, scope of study and project limitation. Literature review that explains research study of different types of power divider was presented in chapter 2. Different designs are presented with different design specification of bending at the corner side. The design process of Power Divider is presented in Chapter 3.

The simulated and measured results of the various types of power divider are presented in Chapter 4. The simulated result such as return loss, isolation is clearly presented. Then, the measurement process is done to validate the simulated results and both results have been compared to each other in terms of different materials used. A discussion of the results is presented clearly with full analysis. Lastly, the conclusion of the project is presented in Chapter 5. This chapter concludes the findings of the project, some key contribution and provides recommendations for futurework.

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